Assessment of organic fertilizers efficacy through the analysis of chlorophyll fluorescence in apple and strawberry.

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Abstract

Trials testing fertilizers deriving from different matrixes (animal manure, vermicompost, plant extracts, microorganisms inocula, and stillage from yeast production) were established in a strawberry plantation (cv. 'Elkat') and in a nursery, managed according to organic farming standards, with apple trees cv. 'Topaz' grafted on M26 rootstock. Standard mineral chemical fertilization and no fertilization were considered as control treatments. To evaluate the effect of these fertilization treatments, quantum efficiency of leaf photosynthetic light energy conversion was measured in vivo using a HandyPEA fluorimeter. The results are indicating that animal manure, alone or in association with the microbial inoculum and the stillage from yeast production performed better in terms of functioning of the photosynthetic system even if providing half amount of mineral nutrients (N, P, K) in comparison to chemical fertilization.

Keywords: organic fertilizers, chlorophyll fluorescence, quantum efficiency, photosynthesis

Introduction

Chlorophyll fluorescence has been routinely used to monitor non-invasively the photosynthetic performance of plants and is providing an informative tool to determine plants' tolerance to unfavorable climatic conditions and to estimate their fertilization requirements (Baker & Rosenqvist, 2004; Kalaji *et al*., 2012). We have thus carried out experiments to assess the capacity of different organic fertilizers and amendments on improving plant fitness by measuring the quantum efficiency of leaf photosynthetic light energy conversion.

Material and Methods

Trials testing different fertilizers deriving from different matrixes were established in a strawberry plantation (cv. 'Elkat') and in a nursery, managed according to organic farming standards, with apple trees cv. 'Topaz' grafted on M26 rootstock. Plots received 5 different treatments to soil or to both soil and leaves (manure, vermicompost extract, manure in association with microorganism consortium or seaweed extract or stillage from yeast production) providing half amount of nutrients in comparison to a standard mineral fertilization, which together with no fertilization were considered as control treatments. To evaluate the effect of these fertilization treatments, quantum efficiency of leaf photosynthetic light energy conversion was measured in vivo (24 measurements for each experimental combination, 3 measurements per tree) after leaf dark adaptation (for 30 minutes, using leaf clips) using a continuous excitation system (HandyPEA fluorimeter - Hansatech Instruments Ltd., UK). A standard protocol was applied with saturation pulse of 1 s duration and 3500 µmol photons m-2 s-1 intensity. Measurements were conducted each month from July to September. A detailed analysis of chlorophyll fluorescence signal was conducted using PEA Plus and Biolyzer 3.0. The results were elaborated by ANOVA and Tukey's test with $p \leq 0.05$ was used to evaluate the significance of differences between means.

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Results and Discussion

The diverse fertilizers applied affected differently several physiological parameters related to the photosynthetic metabolism (Fig. 1). In case of strawberry plants, the highest values for two key parameters assessing the efficiency in the functioning of the photosynthetic system were observed in plants treated with manure in association with the stillage from yeast production. Plants fertilized with manure and the microbial consortium showed a significantly higher value of heat dissipation (DIo/RC) than in control and all other treatments. In case of apple plants, the maximal efficiency of PSII (Fv/Fm) was not affected by any treatment. The highest heat dissipation per reaction center (DIo/RC) was measured in plants treated with animal manure alone or in association with the stillage from yeast production.

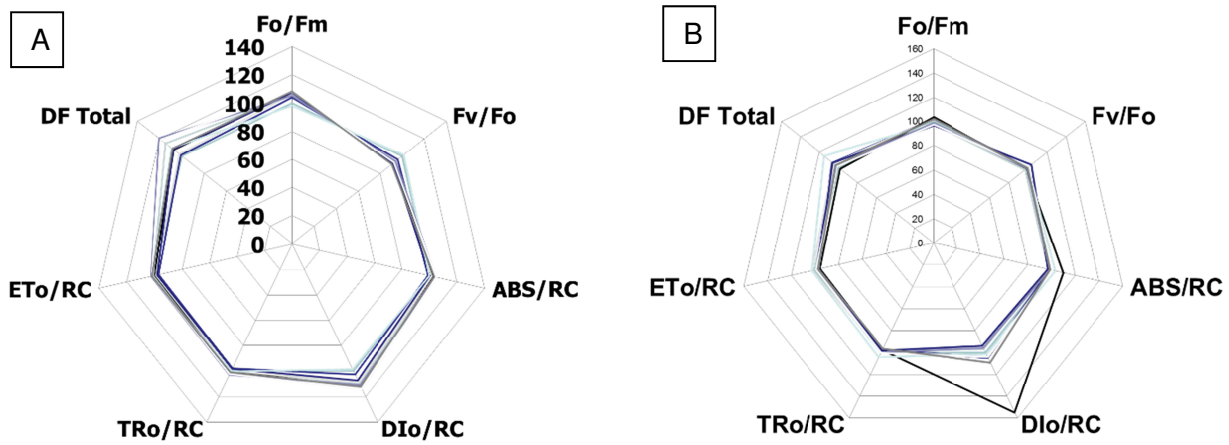

Figure 1: Some chlorophyll fluorescence parameters of apple (A) and strawberry (B) leaves of plants treated with different types of organic fertilizers.

In conclusion, the results are indicating that animal manure, alone or in association with the microbial inoculum or the stillage from yeast production, even if providing half amount of mineral nutrients (N, P, K) in comparison to chemical fertilization, performed better in terms of potential photosynthetic efficiency and functioning of the photosynthetic apparatus. Such effect was positively affecting the growth of both strawberry plants and maiden apple trees.

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References

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